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## तिल का तेल — विशिष्टि

( तीसरा पुनरीक्षण )

## Sesame Oil — Specification

( Third Revision )

ICS 67.200

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भारतीय मानक ब्यूरो  
BUREAU OF INDIAN STANDARDS  
मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली-110002  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI-110002  
[www.bis.org.in](http://www.bis.org.in) [www.standardsbis.in](http://www.standardsbis.in)

## FOREWORD

This Indian Standard (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Oils and Oilseeds Sectional Committee had been approved by the Food and Agriculture Divisional Council.

This standard was originally published in 1954. In its first revision issued in 1963 the oil from the white sesame seeds grown in certain areas of Tripura, Assam and West Bengal, whose characteristics differed considerably from the requirements prescribed earlier, were included. The first revision covered only the expressed type of oil and as there was an urgent need for the formulation of an Indian Standard for the solvent extracted type, IS 4220E : 1967 was issued as an emergency standard. The second revision of IS 547 was brought out in 1968, that amalgamated its earlier revision and IS 4220 E : 1967. The second revision was later amended to introduce scheme for labelling environment friendly products to be known as ECO-Mark at the instance of the Ministry of Environment and Forests (MoEF).

This revision has been carried out to harmonize the standard with *Food Safety and Standards Act*, 2006 and Regulations framed thereunder and *Vegetable Oils Grading and Marking Rules*, 1955.

In this revision the following major changes have been made:

- a) Nomenclatures of the different grades have been changed;
- b) Solvent extracted semi-refined grade has been removed;
- c) Grades used exclusively for industrial purpose have been removed;
- d) Limit of aflatoxin has been prescribed for non-ECO marked edible oils also;
- e) Aflatoxin is determined using High Performance Liquid Chromatography (HPLC) and Enzyme Linked Immunosorbent Assay (ELISA) instead of Thin Layer Chromatography (TLC) prescribed earlier;
- f) Colour of refined oil is determined using 100 mm cell on the Lovibond scale instead of ¼ inch cell prescribed earlier and limits have been changed accordingly; and
- g) Limits of refractive index and iodine value have been changed and limit of hexane has been incorporated to align with *Food Safety and Standards (Food Product Standards and Food Additives) Regulation*, 2011.

In the formulation of this standard, due consideration has been given to *Food Safety and Standards Act*, 2006 and Regulations framed thereunder; *Legal Metrology Act*, 2009 and Rules framed thereunder and the *Essential Commodities Act*, 1955. However, this standard is subject to restrictions imposed under these, wherever applicable.

In reporting the results of a test or analysis made in accordance with this standard, if the final value observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

# Indian Standard

## SESAME OIL — SPECIFICATION

### ( Third Revision )

#### 1 SCOPE

This standard prescribes requirements and methods of sampling and test for sesame oil used for edible purposes and for manufacture of refined oil and *Vanaspati*.

#### 2 REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>IS No.</i>	<i>Title</i>	<i>IS No.</i>	<i>Title</i>
544 : 2014	Groundnut oil — Specification ( <i>third revision</i> )	10339 : 2000	shortenings — Specification ( <i>second revision</i> )
548	Methods of sampling and test for oils and fats:	10910 : 1984	Ghee, <i>VANASPATI</i> , edible oil tins up to 10 kg/litre capacity — Specification ( <i>second revision</i> )
(Part 1) : 1964	Methods of sampling, physical and chemical tests ( <i>revised</i> )	11434 : 1985	Specification for polypropylene and its copolymers for its safe use in contact with foodstuffs, pharmaceuticals and drinking water
(Part 2) : 1976	Purity tests ( <i>third revision</i> )	11704 : 1986	Specification for ionomer resins for its safe use in contact with foodstuffs, pharmaceutical and drinking water
1070 : 1992	Reagent grade water — Specification ( <i>third revision</i> )	12247 : 1988	Specification for ethylene acrylic acid (EAA) copolymers for their safe use in contact with foodstuffs, pharmaceuticals and drinking water
1448 [P : 21] : 2012 /ISO 2719 : 2002	Method of test for petroleum and its products: [P : 21] Determination of flash point — Pensky Martens close cup method ( <i>third revision</i> )	12252 : 1987	Specification for nylon-6 polymer for its safe use in contact with foodstuffs, pharmaceuticals and drinking water
1699 : 1995	Methods of sampling and test for food colours ( <i>second revision</i> )	13576 : 1992	Specification for polyalkylene terephthalates (PET & PBT) for their safe use in contact with foodstuffs, pharmaceuticals and drinking water
3470 : 2002	Hexane, food grade — Specification ( <i>first revision</i> )	13601 : 1993	Ethylene menthacrylic acid (EMAA) copolymers and terpolymers for its safe use in contact with foodstuffs, pharmaceuticals and drinking water — Specification
10142 : 1999	Polystyrene (crystal and high impact) for its safe use in contact with foodstuffs, pharmaceuticals and drinking water — Specification ( <i>first revision</i> )	IS/ISO 14718 : 1998	Ethylene vinyl acetate (EVA) copolymers for its safe use in contact with foodstuffs, pharmaceuticals and drinking water — Specification
10146 : 1982	Specification for polyethylene for its safe use in contact with foodstuffs, pharmaceuticals and drinking water		Animal feedings stuffs — Determination of aflatoxin B1 content of mixed feeding stuffs — Method using high performance liquid chromatography
10151 : 2014	Specification for polyvinyl chloride (PVC) and its copolymers for its safe use in contact with foodstuffs, pharmaceuticals and drinking water		
10325 : 2000	Square tins — 15 kg/litre for ghee, <i>VANASPATI</i> , edible oils and bakery		

#### 3 DEFINITION

For the purpose of this standard, the definitions given in 2 of IS 548 (Part 1) and the following shall apply.

**3.1 Refined Sesame Oil** — Refined sesame oil means oil which is obtained by expression or solvent extraction of sesame oil bearing materials, deacidified either with alkali or physical refining or by miscella refining, by bleaching with adsorbent earth and/or carbon and deodorized with steam.

## 4 TYPES AND GRADES

**4.1** The material shall be of the following types and grades:

- a) *Expressed type*:
  - 1) Refined grade,
  - 2) Raw grade I, and
  - 3) Raw grade II.
- b) *Solvent-extracted type*:
  - 1) Refined grade, and
  - 2) Raw grade.

**4.1.1** All the grades of expressed type and refined grade of solvent extracted type are suitable for direct edible consumption.

**4.1.2** Raw grade of the solvent-extracted type is suitable for making refined oil and *Vanaspati* and not for direct edible consumption.

## 5 REQUIREMENTS

### 5.1 Description

The material shall be obtained from good quality sesame seed cake or from clean and sound seeds from *Sesamum indicum* Linn. syn, *Sesamum orientale* Linn., fam. Pedaliaceae, by a process of solvent extraction or from the oilseeds by a process of expression.

**5.1.1** Solvent extracted type oil shall be obtained from the oleaginous material using solvent hexane conforming to IS 3470.

**5.2** The material shall be clear and free from rancidity, adulterants, sediment, suspended and other foreign

matter, separated water and added colouring and flavouring substances.

**5.2.1** The clarity of the material shall be judged by the absence of turbidity after keeping the filtered sample at 30°C for 24 h.

**5.3** Oils shall be free from non-edible oils and adulterants when tested in accordance with **9, 10, 11, 12, 14, 15** and **16** of IS 548 (Part 2).

**5.4** Oils shall not contain aflatoxin, more than 30 µg/kg, when tested by the method prescribed in IS/ISO 14718 or as prescribed in Annex A.

### 5.5 Baudouin Test

All the raw grades of the material shall respond to the test given in **6** of IS 548 (Part 2). The colour of the acid layer obtained in the test with a one percent solution of the oil in refined groundnut oil (*see* IS 544), shall be not less than 8 red units on the Lovibond scale in a 1 cm cell when tested by the method given in **13** of IS 548 (Part 1).

**5.6** Metal contaminants and pesticide residues shall not exceed the tolerance limits as prescribed in the *Food Safety and Standards (Contaminants, Toxins and Residues) Regulations, 2011*. Approved international standard test method from ISO and AOAC shall be followed.

**5.7** Only permitted antioxidants and antioxidant synergists not exceeding the quantities specified against each as prescribed under the *Food Safety and Standards (Contaminants, Toxins and Residues) Regulations, 2011*, may be used, if required.

**Table 1 Requirements for Sesame Oil**

(Clause 5.8)

Sl No.	Characteristic	Requirement					Method of Test, Ref to
		Expressed			Solvent-extracted		
		Refined Grade (3)	Raw Grade I (4)	Raw Grade II (5)	Refined Grade (6)	Raw Grade (7)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Moisture and insoluble impurities, percent by weight, <i>Max</i>	0.10	0.25	0.25	0.10	0.5	5 and 6 of IS 548 (Part 1)
ii)	Colour on the Lovibond scale, expressed as ( <i>Y</i> + 5 <i>R</i> ), not deeper than	10 <sup>1)</sup>	20 <sup>2)</sup>	20 <sup>2)</sup>	10 <sup>1)</sup>	—	13 of IS 548 (Part 1)
iii)	Refractive index at 40°C	←————— 1.464 6 to 1.466 5 —————→					10 of IS 548 (Part 1)
iv)	Specific gravity at 30°C/30°C	←————— 0.915 to 0.919 —————→					11 of IS 548 (Part 1)
v)	Saponification value	←————— 188 to 193 —————→					15 of IS 548 (Part 1)
vi)	Iodine value (Wijs)	←————— 103 to 120 —————→					14 of IS 548 (Part 1)
vii)	Acid value, <i>Max</i>	0.5	4.0	6.0	0.5	—	7 of IS 548 (Part 1)
viii)	Unsaponifiable matter, percent by mass, <i>Max</i>	1.5	1.5	2.5	1.5	2.5	8 of IS 548 (Part 1)
ix)	Bellier turbidity temperature, °C, <i>Max</i>	—	22	22	—	—	13 of IS 548 (Part 2)
x)	Flash point (Pensky-Martens), closed, °C, <i>Min</i>	—	—	—	250	90	IS 1448 [P : 21]
xi)	Hexane, ppm, <i>Max</i>	—	—	—	5.00	5.00	Annex B

<sup>1)</sup> in a 100 mm cell.

<sup>2)</sup> in a 10 mm cell.

<sup>1)</sup> in a 100 mm cell.

<sup>2)</sup> in a 10 mm cell.

**5.8** The material shall also comply with the requirements given in Table 1.

### 5.8 Optional Requirements for ECO-Mark

**5.8.1** The product shall conform to the requirements of quality as given in 5.1 to 5.7.

**5.8.1.1** The manufacturers shall produce to BIS environmental consent clearance from the concerned State Pollution Control Board as per the norms laid down under the *Water (Prevention and Control of Pollution) Act, 1974*; *Air (Prevention and Control of Pollution) Act, 1981*; *Water (Prevention and Control of Pollution) Cess Act, 1977* respectively, along with the authorization, if required, under the *Environment (Protection) Act, 1986*, while applying for ECO BIS Mark.

**5.8.1.2** The product shall not contain aflatoxin, more than 5 µg/kg, when tested by the method prescribed in IS/ISO 14718.

**5.8.1.3** The product shall not contain any of the toxic metals in excess of the quantities prescribed in Table 2.

**Table 2 Limits for Toxic Metals**

(Clause 5.8.1.3)

Sl No.	Characteristic	Requirement	Method of Test, Ref to
(1)	(2)	(3)	(4)
i)	Lead, mg/kg, <i>Max</i>	0.5	15 of IS 1699
ii)	Arsenic, mg/kg, <i>Max</i>	0.5	-do-
iii)	Cadmium, mg/kg, <i>Max</i>	1.0	-do-
iv)	Mercury (total) mg/kg, <i>Max</i>	0.25	-do-

## 6 PACKING

**6.1** The material shall be supplied in suitable well-closed tin or plastic containers, as agreed to between the purchaser and the supplier. Tin or plastic containers once used, shall not be re-used for packaging of edible oils and fats.

Containers made of plastic materials shall be as per IS 10142 or IS 10146 or IS 10151 or IS 10910 or IS 11434 or IS 11704 or IS 12247 or IS 12252 or IS 13601 or IS 13576.

Containers made of tin shall be as per IS 10325 or IS 10339.

**6.1.1** For ECO-Mark, the product shall be packed in such packages which are made from recyclable (that is which can be re-processed to manufacture any useful product) or biodegradable materials.

**6.2** Types and grades not suitable for direct edible consumption shall not be packed in consumer packs.

## 7 MARKING

**7.1** The containers shall be marked in English or Hindi in *Devnagri* script with the following information:

- Name, trade name, type and grade of the oil;
- Name and business particulars of the manufacturer;
- Net quantity of the contents in the container;
- Batch number, month and year of manufacture;
- Free from argemone oil;
- Nutritional information* — Nutritional information or nutritional facts per 100 g or 100 ml or per serving of the product shall be given on the label containing the following:
  - Energy value, in kcal;
  - Amounts of protein, carbohydrate (specify quantity of sugar) and fat, in gram (g) or ml;
  - Amount of any other nutrient for which a nutrition or health claim is made:
 

Provided that where a claim is made regarding the amount or type of fatty acids or the amount of cholesterol, the amount of saturated fatty acids, monounsaturated fatty acids and polyunsaturated fatty acids, in gram (g), and cholesterol, in milligram (mg), shall be declared, and the amount of trans fatty acid, in gram (g), shall be declared in addition to the other requirement stipulated above.
- Any other requirement as stipulated under *Food Safety and Standards Act, 2006* and Regulations framed thereunder and *Legal Metrology Act, 2009* and rules framed thereunder.

**7.2** The container of imported edible oil shall also bear the word, 'Imported', as prefix to type and grade of oil.

**7.3** In addition in the case of the types and grades which are not suitable for direct edible consumption (*see 4.1.2*), the following information shall be suitably marked, either printed on the label affixed to the container or lithographed or stencilled thereon with indelible ink, in a type size of not less than 50 mm:

'NOT FOR DIRECT EDIBLE CONSUMPTION'

**7.4** The package, label or the advertisement of edible oils and fats shall not use the expressions 'Super-Refined', 'Extra-Refined', 'Micro-Refined', 'Double-Refined', 'Ultra-Refined', 'Anti-Cholesterol', 'Cholesterol Fighter', 'Soothing to Heart', 'Cholesterol Friendly', 'Saturated Fat Free' or such other expressions which are an exaggeration of the quality of the product.

7.5 For ECO-Mark the containers shall be marked with the following:

- a) List of identified critical ingredients in descending order of quantity, percent by mass, which shall include 'made from sesame oil';
- b) Brief criteria for which the product has been labelled for ECO-Mark; and
- c) Shelf life of the product.

#### 7.6 BIS Certification Marking

The product may also be marked with the Standard Mark.

7.6.1 The use of the Standard Mark is governed by the

provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

#### 7.7 ECO-Mark

The product may also be marked with the ECO-Mark, the details of which may be obtained from Bureau of Indian Standards.

### 8 SAMPLING

Representative samples of the material shall be drawn as given in 3 of IS 548 (Part 1).

## ANNEX A

(Clauses 5.4 and 5.8.1.2)

### DETERMINATION OF TOTAL AFLATOXIN BY ELISA

#### A-1 PRINCIPLE

Antibodies specific to aflatoxins B1, B2 and G1 are immobilized on the filter, and toxin (aflatoxin B1) is labelled with an enzyme (horseradish peroxidase). Binding of toxin-enzyme conjugate by immobilized antibodies is inhibited by addition of free toxin present in the test sample. Bound enzyme catalyses oxidation of substrate to form a blue complex. Development of colour indicates that the test sample contains aflatoxin.

#### A-2 APPARATUS

##### A-2.1 Antibody Coated Solid Support

##### A-2.2 Aflatoxin Enzyme Conjugate

##### A-2.3 High Speed Blender

##### A-2.4 Variable 100 - 1 000 µl Micropipettes

##### A-2.5 Glass Culture Tubes

##### A-2.6 Filters

##### A-2.7 Timer

##### A-2.8 Silicon Carbide Boiling Chips

#### A-3 REAGENTS

**A-3.1 Wash Solution - Phosphate Buffered Saline Solution** — Dissolve 0.23 g  $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$ , 1.95 g  $\text{K}_2\text{HPO}_4 \cdot 3\text{H}_2\text{O}$ , 8.70 g NaCl, 0.125 ml Tween 20 and 10 mg thimerosal in 900 ml  $\text{H}_2\text{O}$ , adjust pH to 7.2 and dilute to 1 litre.

**A-3.2 Buffer** — 0.1 percent Bovine serum albumin in phosphate buffer saline solution containing 0.05 percent thimerosal.

**A-3.3 Substrate Solution A**, tetramethylbenzidine (TMB), (0.4 g/l  $\text{H}_2\text{O}$ ), pH 8.3.

**A-3.4 Substrate Solution B**, hydrogen peroxide (0.02 percent  $\text{H}_2\text{O}_2$  in 0.13 percent aq. citric acid solution, pH 3.0).

##### A-3.5 Methanol

##### A-3.6 Hexane

##### A-3.7 Chloroform

##### A-3.8 $\text{NaH}_2\text{PO}_4$

##### A-3.9 $\text{K}_2\text{HPO}_4$

##### A-3.10 NaCl

##### A-3.11 Tween 20

##### A-3.12 Bovine Serum Albumin

#### A-4 PROCEDURE

##### A-4.1 Preparation of Sample

**A-4.1.1** Weigh 50 g of sample into blender jar.

**A-4.1.2** Mix with 250 ml of 55 percent methanol and 45 percent water (see IS 1070).

**A-4.1.3** Mix 100 ml hexane and blend for 1 min at high speed.

**A-4.1.4** Filter mixture and recover filtrate.

**A-4.1.5** Leave for 5 min and remove the lower phase containing methanol water (*see A-4.1.2*).

#### **A-4.2 Testing**

**A-4.2.1** Bring all reagents at room temperature (20-23°C).

**A-4.2.2** Prepare fresh substrate in small culture tubes by mixing 500 µl substrate solution A with 500 µl substrate solution B for each reaction sites used.

**A-4.2.3** Add 100 µl test extract to 200 µl buffer (*see A-3.2*).

**A-4.2.4** Thoroughly mix the diluted test extract and apply 100 µl diluted test extract to the centre of membrane. Using timer, wait for 1 min.

**A-4.2.5** Apply 100 µl (2 drops) enzyme solution to the centre of membrane. Using timer, wait for 1 min.

**A-4.2.6** Wash with 1.5 ml (30 drops) wash solution

added drop wise.

**A-4.2.7** Add the entire content of the substrate solution 1.0 ml from each test tube to each reaction site. Wait for 1 min and immediately observe site (centre of cup) for blue colour development (negative) or no colour development (positive).

#### **A-4.3 INTERPRETATION OF RESULTS**

Observe the reaction site (centre of the cup) for a blue colour or no colour development at exactly 1 min after adding the substrate A and B mixture (*see A-3.3* and *A-3.4*).

Negative — If the reaction site (centre of the cup) turns light blue or darker, test sample contains total aflatoxin B1, B2 and G1.

Positive — If no blue colour is observed in the reaction site (centre of cup) and reaction site remains completely white (no colour change) for at least 1 min, the test sample contains aflatoxin B1, B2 and G1.

## **ANNEX B**

[Table 1, *Sl No. (xi)*]

### **DETERMINATION OF HEXANE RESIDUES IN OILS AND FATS**

#### **B-1 PRINCIPLE**

The residual hexane content is the quantity of volatile hydrocarbons remaining in the fats and oils following processing involving the use of solvents. The volatile hydrocarbons are desorbed by heating the sample at 80°C in a closed vessel after addition of an internal standard. After determination of a calibration factor, hydrocarbons in the head space are determination of a calibration factor, hydrocarbons in the head space are determined by gas chromatography using packed or capillary columns. Results are expressed as hexane, in mg/kg (or ppm). The method is applicable to the determination of 'free' volatile hydrocarbons expressed in terms of hexane remaining in animal and vegetable fats and oils after extraction with hydrocarbon based solvents.

#### **B-2 APPARATUS**

**B-2.1 Gas Chromatograph** — Gas chromatograph having,

- thermostatic column capable of maintaining the desired column temperature within  $\pm 1^\circ\text{C}$ ;
- sample inlet system, separately thermostated

which can be maintained at a minimum temperature of 100°C. If a capillary column is used, the inlet system must be capable of a 1/100 split injection. For serial analysis a headspace gas chromatograph with automatic sample injection and tempering bath is satisfactory; and

- flame ionization detector which can be separately thermostated and maintained at a minimum of 100°C.

**B-2.2 Recorder** — If a recorder trace is to be used for calculating the composition of the samples analyzed, an electronic recorder of high precision is required or else use electronic integrator (*see B-2.3*)

**B-2.3 Electronic Integrator**, which permits rapid and accurate calculations.

**B-2.4 Chromatographic Column**, either packed or capillary column with the following minimum requirements:

- Packed column* — Stainless steel or glass, approximately 2 m long and 3.175 mm internal diameter with acid washed and silanized

diatomaceous earth, 150-180 mm particle size (80-100 mesh chromosorb WAW is suitable), stationary phase — squalene consisting of 10 percent of packing.

- b) *Capillary column* — Glass or fused silica approximately 30 m long and 0.3 mm internal diameter.
- c) *Stationery phase* — Methyl polysiloxane (film thickness 0.2 m).

**B-2.5 Syringe** — 1 ml, 10 ml, 1 000 ml capacity, gas tight.

**B-2.6 Septum Vial** — 20 ml capacity.

**B-2.7 Septa and Aluminium Caps Suitable for Septum Vials Together with Crimping Pliers** — The septa must be resistant to oils and solvents (butyl rubber or red rubber is recommended).

**B-2.8 Tongs**, suitable for holding septum vials.

**B-2.9 Heating Bath**, with clamps for holding septum vials, thermostatically regulated and capable of maintaining a temperature of 80°C. For continuous operation glycerol is recommended as heating liquid.

**B-2.10 Shaking Machine**

### B-3 REAGENTS

#### B-3.1 Gases

- a) *Carrier* — Helium (preferred for better resolution) or Nitrogen 99.99 percent pure, dried and containing a maximum of 10 mg O<sub>2</sub>/kg.
- b) *Flame Ionization Detector* — Hydrogen, minimum purity 99.95 percent, air or oxygen, dry, hydrocarbon free (less than 2 ppm hydrocarbon equivalent to CH<sub>4</sub>).

**B-3.2 Technical Hexane or Light Petroleum**, with a composition similar to that used in industrial extraction or failing these *n*-hexane. For calibration, technical extraction hexane is preferred.

**B-3.3 *n*-Heptane (Internal standard)** — analytical reagent grade.

**B-3.4 Vegetable Oil** — Solvent free, freshly refined and deodorized. The oil is to be used for calibration and should be of a similar nature as the sample. It should be free from extraction solvent (less than 0.01 percent).

### B-4 SAMPLING AND SAMPLE STORAGE

It is essential that loss of solvent from the sample be prevented. The laboratory sample should be in a completely sealed condition and stored at 4°C. Plastic

containers should not be used. Sample analysis should be carried out immediately when the sample container is opened.

### B-5 GC OPERATING CONDITIONS

Carrier gas flow depends on the carrier gas and the type of column being used for analysis and should be optimized accordingly. The flow of hydrogen and air or oxygen to the FID should be optimized according to the manufacturer's recommendation. Injector and detector temperatures should be set at about 120°C. The column should be maintained at 40°C.

### B-6 PROCEDURE

#### B-6.1 Determination of the Calibration Factor

Weigh to the nearest 0.01 g, 5 g of solvent free vegetable oil (*see B-3.4*) into each of the 7 septum vials. Seal each vial with a septum and cap. By means of a syringe add technical hexane to 6 of the seven vials (in the vial with no added solvent is the blank) according to the following table:

ml/5g	0.5	1	2	4	7	10
mg/100g	67	134	268	536	938	1 340

One vial remains without the addition of solvent.

If *n*-hexane is used for calibration the following table applies:

ml/5g	0.5	1	2	4	7	10
mg/100g	66	132	264	528	924	1 320

Shake the 6 vials containing the solvent in the shaking machine vigorously for 1 h. Using the syringe add 5 ml of internal standard (*see B-3.3*) to each of the 7 vials. Successively immerse the vials up to the neck in the heating bath at 80°C at intervals of approximately 15 min. This time interval depends on the duration of the GC analysis which is complete on the elution of the internal standard (*n*-heptane). The samples must be placed in the heating at intervals such that each sample is tempered for exactly 60 min.

Warm the gas tight syringe to 60°C. After tempering at 80°C for exactly 60 min and without removing the vial from the heating bath, use the gas tight syringe and withdraw through the septum 1 000 µl (1 ml) of the head space above the oil. inject immediately into the gas chromatograph. For each of the vial containing added solvent a calibration factor *F* may be determined by the following formula:

$$F = \frac{C_s \times A_1}{(A_H - A_B - A_1) \times C_1}$$



where

$A_H$  = total peak area of solvent hydrocarbons including the area of internal standard present in the spiked oil. For identification purposes a typical chromatogram of solvent composition should be obtained. Hydrocarbons which usually make up the technical hexane are 2 methyl pentane, 3 methyl pentane, methyl cyclopentane, cyclohexane, etc. Do not include peaks due to oxidation products which may be present in significant amounts.

$A_B$  = peak area of the solvent hydrocarbons present in the oil to which solvent has not been added (blank) less the peak area of the internal standard.

$A_1$  = peak area corresponding to the internal standard in the spiked samples.

$C_1$  = quantity of the internal standard added expressed, in mg/kg, of the oil.

$C_s$  = quantity of technical hexane added to the oil present in the vial expressed, in mg/kg, of the oil.

Express the results to the third decimal place.

Calibration factors of the six standards should be approximately the same. The mean calibration factor should be 0.45, if *n*-heptane is used and 0.57, if cyclohexane is used.

The factor (*F*) so evaluated can be used for determining vial quantities of hexane less than 60 mg/kg. If the value of *F* found for the vial containing 0.5 ml of hexane is significantly below the mean value, this deviation is probably due to difficulty in introducing exactly 0.5 ml and this determination must be either eliminated or repeated. For quantities of hexane between 10 and 20 mg/kg it is better to prepare calibration standards by adding 2 ml of internal standard instead of 0.5 ml.

### B-6.2 Sample Analysis

Weigh to the nearest 0.01 g, 5 g of the test sample into

a septum vial as quickly as possible and close immediately with a septum and cap. Using a syringe add through the septum exactly 5ml of the internal standard. Shake vigorously by hand for about 1 min and then immerse the vial up to the neck in the heating bath. At 80°C for exactly 60 min. Warm the gas tight syringe to 60°C. After tempering at 80°C for exactly 60 min use the gas tight syringe and take from the vial without removing it from the bath 1 000 ml (1 ml) of the head space above the sample. Immediately inject into the gas chromatograph. Carry out two determinations in rapid succession on each sample.

### B-7 CALCULATION

The residual solvent expressed, in mg/kg (ppm), is given by the following formula:

$$W = \frac{(A_H - A_1) \times F \times C_1}{A_1}$$

where

$A_H$  = total peak area of solvent hydrocarbons including the area of internal standard. Hydrocarbons which usually make up the technical solvents are 2 methyl pentane, 3 methyl pentane, methyl cyclopentane, cyclohexane, etc. Do not include peaks due to the oxidation products. Some of these products may be present in significant amount.

$A_1$  = peak area corresponding to internal standard in the sample.

$C_1$  = quantity of the internal standard added, in mg/kg.

$F$  = calibration factor obtained in procedure.

NOTE — For an addition of 5 ml of heptane/5 g of sample  $C_1$  = 680 mg/kg and  $C_1$  = 750 mg/kg, if cyclohexane is used.

Report as the final result the mean of the results of two determinations.



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### BUREAU OF INDIAN STANDARDS

#### Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002

Telephones : 2323 0131, 2323 3375, 2323 9402

Website: [www.bis.org.in](http://www.bis.org.in)

#### Regional Offices:

Telephones

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg  
NEW DELHI 110002

{ 2323 7617  
2323 3841

Eastern : 1/14 C.I.T. Scheme VII M, V. I. P. Road, Kankurgachi  
KOLKATA 700054

{ 2337 8499, 2337 8561  
2337 8626, 2337 9120

Northern : Plot No. 4-A, Sector 27-B, Madhya Marg, CHANDIGARH 160019

{ 26 50206  
265 0290

Southern : C.I.T. Campus, IV Cross Road, CHENNAI 600113

{ 2254 1216, 2254 1442  
2254 2519, 2254 2315

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